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Trends and Survival Between Ethnic Groups After Stroke: The South London Stroke Register

Yanzhong Wang, Anthony G. Rudd and Charles D.A. Wolfe

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Trends and Survival Between Ethnic Groups After Stroke

The South London Stroke Register

Yanzhong Wang, PhD; Anthony G. Rudd, FRCP; Charles D.A. Wolfe, MD, FFPHM

Background and Purpose—To identify trends and differences between ethnic groups in survival after first-ever stroke and examine factors influencing survival.

Methods—Population-based stroke register of first in a lifetime strokes between 1995 and 2010. Baseline data were collection of sociodemographic factors, stroke subtype, case mix, risk factors before stroke, and receipt of effective acute stroke processes. Survival curves were estimated with Kaplan-Meier methods, and survival analyses were undertaken using Cox Proportional-hazards models.

Results—Survival improved significantly over this 16-year period ($P < 0.0001$). Black Caribbean and black African had a reduced risk of all-cause mortality compared with white patients (hazard ratio, 0.85 [95% confidence interval, 0.74–0.98] and 0.61 [0.49–0.77], respectively) after adjustment for confounders. This survival advantage of black Caribbean/black African over white mainly existed in older patients (over 65). Recent stroke, being black Caribbean/black African, and stroke unit admission were associated with better survival.

Conclusions—Survival has improved in a multiethnic population over time. The independent survival advantage of black Caribbean and black African over White group in those aged over 65 may be a healthy migrant effect of first generation migrants. The increase in admission to a stroke unit may contribute to the improvement in survival after stroke. (*Stroke*. 2013;44:380-387.)

Key Words: ethnicity ■ epidemiology ■ risk factors ■ stroke ■ survival

Stroke is the fifth leading cause of death in low-income countries and the second in high-income countries after heart disease.¹ Overall burden of disease data from the World Health Organization show stroke still in the top 6 based on disability adjusted life-years.² Mortality rates for stroke are reported to be declining in western countries supposedly because risk reduction programmes are implemented, yet there are epidemics of obesity, and there has been migration of higher risk communities, such as people of African origin, where in the United States United Kingdom.^{3–7} With an ageing population, despite falling incidence rates, the numbers of strokes will increase as risk increases exponentially with age.^{5,6}

Ethnic differences in stroke incidence, mortality, and survival have been reported^{4,8–15} with conflicting results showing the disadvantages or advantages of black patients over white patients. Bravata et al⁸ reported that blacks in the United States had a higher incidence of stroke and more severe strokes than whites, and ethnic differences existed in the prevalence of stroke risk factors. Kissela et al¹¹ also reported that blacks have higher age-adjusted mortality rates than whites because of higher stroke incidence rates, particularly in the young and middle-aged in the United States. Cushman et al⁹

showed that blacks <75 years have more than twice the risk for stroke death than whites in the United States. Despite the commonly held belief that black patients have higher stroke mortality, several studies have reported better survival in black patients with stroke. Wolfe et al¹³ showed that black patients in a south London population were more likely to survive than white patients. Xian et al,¹⁴ based on the data from 164 hospitals in New York, also reported that among patients with acute ischemic stroke, black patients had lower mortality than white patients and concluded that this could be the result of differences in receipt of effective interventions. However, the studies to date generally lack data to minimize the effect of confounding.

Few studies have compared the incidence and mortality of stroke in black and white people from the same population.¹⁶ Two population-based stroke registers in US cities, the Northern Manhattan Stroke Study (NOMASS)^{17,18} and The Greater Cincinnati/Northern Kentucky Stroke Study (GCNKSS),¹¹ found twice the incidence of stroke adjusted for age and sex in black people than in white people, but did not find a significant difference between black people and white people in survival after stroke. The South London Stroke

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Register (SLSR) is a prospective population-based register documenting all first-in-a-lifetime strokes since January 1, 1995 in a multiethnic inner city population.^{7,13} The SLSR now includes >4000 patients with a first-ever stroke and they are deeply phenotyped including default variables, such as sociodemography, case mix, acute stroke care, and particularly ethnicity, with long-term follow-ups up to 16 years. Based on data from SLSR, we aim to investigate trends and differences between ethnic groups in long-term survival after first-ever stroke and examine the influence of year of stroke, sociodemographic, case mix, stroke subtype, and acute stroke care factors on survival.

Methods

Study population, case ascertainment, and data collection have been described in detail elsewhere.^{10,19} In brief, the SLSR is a prospective population-based stroke register set up in January 1995, recording all first-ever strokes in patients of all ages for an inner area of South London based on 22 electoral wards in Lambeth and Southwark. Data collected between 1995 and 2011 were used in this analysis. Follow-up data were collected by personal, postal, or face-to-face interviews with patients and their carers. Patients were assessed at 3 months and annually after stroke. All follow-up assessments included in the present study were completed by May 31, 2011.

Sociodemographic Characteristics

Ethnic origin (self-definition, census question) was stratified into white, black Caribbean (BC), black African (BA), and others/unknown. Socioeconomic status was categorized as nonmanual, manual and others/unknown, according to the patient's current or most recent employment using the UK General Register Office occupational codes.

Risk Factors Before Stroke

Hypertension (general practice or hospital records of high blood pressure >140 mm Hg systolic or >90 mm Hg diastolic); myocardial infarction; atrial fibrillation; previous transient ischemic attack; diabetes mellitus (self-reported); and current smoking status.

Case Mix

Case severity variables included urinary incontinence, Glasgow Coma Scale, dichotomized to <13 (severe/moderate) and ≥13 (mild), Barthel index before stroke, dichotomized to <15 (severe disability) and ≥15 (moderate/independent disability), and Barthel index at 7 days after stroke, dichotomized to <15 (severe disability) and ≥15 (moderate/independent disability).

Stroke Subtype

Classification of the pathological subtype (cerebral infarction, primary intracerebral hemorrhage, and subarachnoid hemorrhage) was based on results from at least one of the following: brain imaging, cerebrospinal fluid analysis, or necropsy examination. Cases without pathological confirmation of stroke subtype were unclassified.

Effective Interventions After Stroke

Patients were classified as (1) not admitted to hospital; (2) admitted to stroke unit; (3) admitted to general medical ward/intensive care; and (4) unknown.

Statistical Methods

Data were available from January 1, 1995 and we were able to obtain complete records up to May 31, 2011. We included all index cases (first-ever stroke) up to December 31, 2010 and incorporated

follow-up until May 31, 2011. Survival time was from date of stroke to date of death, confirmed by the Office for National Statistics. Patients with no record of death were censored at May 31, 2011.

Continuous variables are summarized as mean (SD) and categorical data as count (percentage). Student *t* test and Wilcoxon signed-rank test were used to test differences in continuous variables where appropriate, and the χ^2 test used for proportions. Survival curves were made among stroke patients by consecutive time periods (per 4 years), ethnic groups, and stroke subtypes, using the Kaplan-Meier method (unadjusted) and log rank tests. Multivariate survival analyses were undertaken using Cox Proportional-Hazards models to determine the prognostic value of sociodemographic factors, case mix, stroke subtype, effective intervention, and risk factors before stroke. The event studied was all-cause mortality.

Possible interactions between ethnicity and other explanatory variables, such as age, before stroke risk factors, and stroke unit care, were investigated by constructing interaction terms in the Cox model. Age-stratified survival analyses by a 10-year age band and also by using a cut-off age of 65 were carried out to examine survival differences between BC/BA and white patients within each age band or group. The proportional-hazards assumption for each covariate was tested using the scaled Schoenfeld residuals, with the covariate being stratified if its proportionality assumption was not met.

All tests were 2-tailed, and $P < 0.05$ was considered statistically significant. Hazard ratios (HR) with 95% confidence interval of possible influencing factors were calculated in Cox models. All statistical analyses were performed with statistical software R, version 2.11.1.

Ethics

Patients or their relatives gave written informed consent to participate in the study. Ethical approval was from the ethics committees of Guy's and St Thomas' Hospital Trust, King's College Hospital, Queens Square, and Westminster Hospital (London).

Results

A total of 4212 patients were registered over the study period. Of these, 3005 (71.3%) were white, 536 (12.7%) BC, 296 (7.0%) BA, and 375 (8.9%) others or missing ethnicity. Table 1 shows characteristics of stroke patients by each ethnic group. BC and BA patients had their first-ever stroke (mean age, 66.6 and 56.7 years old, respectively) much earlier than white patients (mean age, 72.8 years old) ($P < 0.0001$). Compared with BC and BA, white patients had increased acute stroke urine incontinence (43.8% versus 39.2% and 31.8%, respectively, $P = 0.0001$), more with severe disability before stroke (Barthel index <15) (7.8% versus 5.4% and 0.7%, respectively, $P < 0.0001$), and were less likely to be admitted to a stroke unit (44.4% versus 54.9% and 57.8%, respectively, $P < 0.0001$). For before stroke risk factors, fewer BC and BA patients were current smokers ($P < 0.0001$). High blood pressure and diabetes mellitus were more commonly observed in BC and BA patients ($P < 0.0001$) with the reverse for myocardial infarction ($P < 0.0001$), atrial fibrillation ($P < 0.0001$), and previous transient ischemic attack ($P = 0.0048$).

Survival Analysis

Among 4212 patients with a first-ever stroke between January 1, 1995 and December 31, 2010, 2605 (61.8%) have died (all causes) by May 31, 2011. 2037/3005 (67.8%), 276/536 (51.5%), 92/296 (31.1%) deaths were observed in white, BC, and BA patients, respectively. Median survival was 2.15 years for white, 3.33 years for BC, and 5.04 years for BA patients. The 30-day case fatality rate was 23.0% (690/3005), 13.2%

Table 1. Baseline Characteristics of Patients With First-ever Stroke (n=4212)

	All (n=4212)	White (n=3005)	Black Caribbean (n=536)	Black African (n=296)	P Value
Age	70.2 (14.9)	72.8 (13.9)	66.6 (14.0)	56.7 (14.3)	<0.0001
Year of stroke					<0.0001
1995–1998	1305 (31.0%)	1028 (34.2%)	163 (30.4%)	50 (16.9%)	
1999–2002	1074 (25.55%)	753 (25.1%)	115 (21.5%)	87 (29.4%)	
2003–2006	994 (23.6%)	671 (22.3%)	135 (25.2%)	77 (26.0%)	
2007–2010	839 (19.9%)	553 (18.4%)	123 (22.9%)	82 (27.7%)	
Sex					0.0406
Male	2120 (50.3%)	1466 (48.8%)	284 (53%)	163 (55.1%)	
Socioeconomic status					<0.0001
Nonmanual	1127 (26.8%)	832 (27.7%)	94 (17.5%)	103 (34.8%)	
Manual	2216 (52.6%)	1562 (52.0%)	355 (66.2%)	131 (44.3%)	
Others/unknown	869 (20.6%)	611 (20.3%)	87 (16.2%)	62 (20.9%)	
Case mix					
Glasgow Coma Scale<13	1144 (27.2%)	832 (27.7%)	130 (24.3%)	72 (24.3%)	0.1283
Incontinent of urine	1766 (41.9%)	1317 (43.8%)	210 (39.2%)	94 (31.8%)	0.0001
Pre-Barthel<15	281 (6.7%)	234 (7.8%)	29 (5.4%)	2 (0.7%)	<0.0001
Post-Barthel (7 d) <15	1827 (43.4%)	1335 (44.4%)	237 (44.2%)	115 (38.9%)	0.0305
Stroke subtype					<0.0001
Infarct	3109 (73.8%)	2269 (75.5%)	399 (74.4%)	192 (64.9%)	
PICH	540 (12.8%)	338 (11.2%)	71 (13.2%)	61 (20.6%)	
SAH	212 (5.0%)	131 (4.4%)	36 (6.7%)	19 (6.4%)	
Unclassified/unknown	351 (8.3%)	267 (8.9%)	30 (5.6%)	24 (8.1%)	
Effective intervention					<0.0001
Stroke unit admission	1953 (46.3%)	1333 (44.4%)	294 (54.9%)	171 (57.8%)	
Nonadmitted patient	501 (11.9%)	371 (12.3%)	49 (9.1%)	26 (8.8%)	
Unknown	87 (2.1%)	56 (1.9%)	12 (2.2%)	8 (2.7%)	
Risk factors prior to stroke:					
Hypertension	2553 (60.6%)	1764 (58.7%)	393 (73.3%)	198 (66.9%)	<0.0001
Myocardial infarction	434 (10.3%)	352 (11.7%)	37 (6.9%)	12 (4.1%)	<0.0001
Atrial fibrillation	657 (15.6%)	577 (19.2%)	36 (6.7%)	15 (5.1%)	<0.0001
Previous TIA	657 (15.6%)	379 (12.6%)	50 (9.3%)	23 (7.8%)	0.0048
Diabetes	753 (17.9%)	397 (13.2%)	191 (35.6%)	62 (20.9%)	<0.0001
Current smoker	1317 (31.3%)	1014 (33.7%)	150 (28.0%)	43 (14.5%)	<0.0001

Summary statistics are mean (SD) or count (%) as appropriate. Infarct indicates cerebral infarction; PICH, primary intracerebral hemorrhage; SAH, subarachnoid hemorrhage; and TIA, transient ischemic attack.

(71/536), and 8.8% (26/296) for white, BC, and BA patients, respectively.

When we compared patients registering in each consecutive 4-year period from 1995 to 2010, we found that survival gradually improved for all patients over this 16-year period as shown in Figure 1 (log rank test $P<0.0001$). Further Kaplan-Meier analyses showed survival improved significantly over time for white ($P<0.0001$), and marginally for BC ($P=0.0275$) and BA patients ($P=0.0703$) (Figure 1).

There was a clear survival difference among white, BC, and BA patients (Figure 2), with white patients having poorer survival (log rank test $P<0.0001$). Age-stratified analyses by a 10-year age band showed this survival advantage of BC/BA over white mainly existed in patients over 65 years old (Figure 3). Patients under 45 were categorized as 1 group

because the number was relatively small. The same applied to patients over 85.

There was also a survival difference among different stroke subtypes (Figure 4, log rank test $P<0.0001$). Patients with primary intracerebral hemorrhage and subarachnoid hemorrhage had an increased chance of death in the acute phase compared with patients with cerebral infarction.

Factors influencing all-cause mortality were described in Table 2. Multivariate survival analyses showed that recent stroke (consecutive 4-year periods, 1995–2010) (HR ranges, 0.56–0.79; $P<0.001$), being BC (HR, 0.85 [0.74–0.98]) or BA (HR, 0.61 [0.49–0.77]) and stroke unit admission (HR, 0.75 [0.68–0.83]) was associated with better survival, after adjustment for potential confounding factors, such as sociodemography, case mix, stroke subtype, and risk factors before stroke.

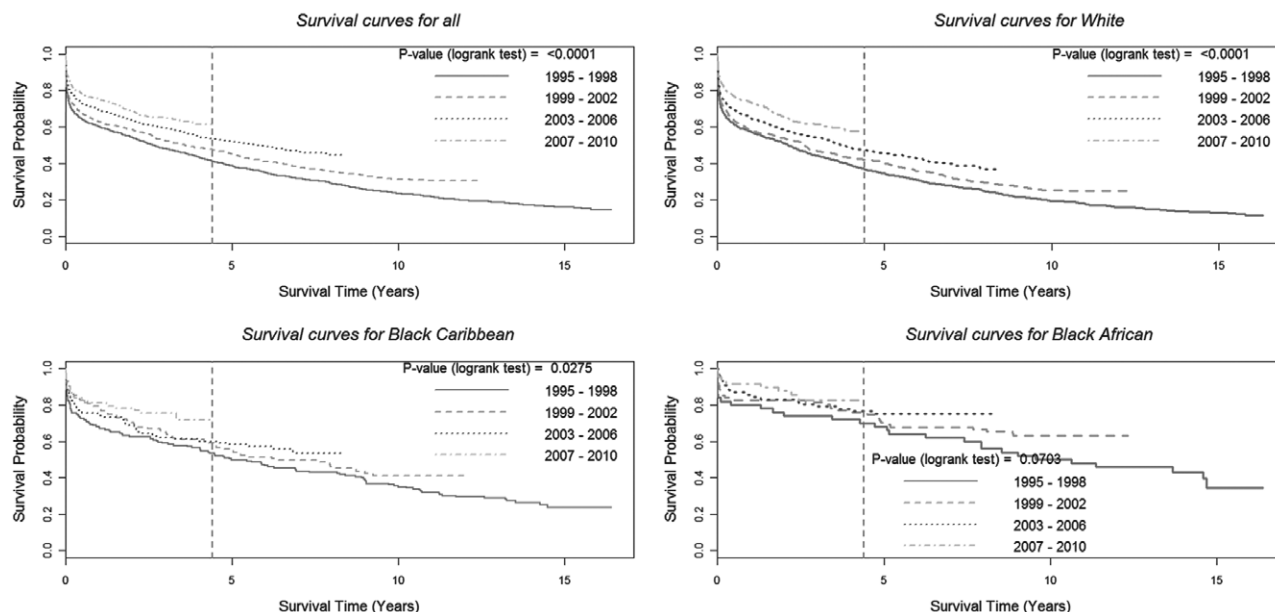


Figure 1. Kaplan-Meier survival (KM) curves for patients with first-ever stroke by cohort and ethnicity.

We examined possible interactions between ethnicity and other variables, such as age, before stroke risk factors, and stroke unit care, and only found age marginally interacted with ethnicity (BC*age: $P=0.0641$; BA*age: $P=0.0624$) (Table I in the online-only Data Supplement). The proportionality test (Schoenfeld residuals) also showed that age did not follow the proportional-hazards assumption ($P<0.001$). Age-stratified survival analyses by a 10-year age band and also by using a cut-off age of 65 were, therefore, carried out and showed the survival advantage of BC and BA over white patients mainly existed in the over-65-year-old age bands or group (HR, 0.77 [0.65–0.90]; HR, 0.55 [0.40–0.76], respectively) (Table II in the online-only Data Supplement). The result was consistent with the age-stratified Kaplan-Meier analyses in Figure 3.

Discussion

This study showed that survival had improved in a multiethnic population over time and it was more evident in white compared with BC and BA patients. BC and BA were more likely to survive than white patients, even after adjustment for confounders. However, this independent survival advantage

of black (BC/BA) over white mainly existed in patients over 65 years old. Recent stroke, being black (BC/BA), and stroke unit admission were found to be associated with better survival. SLSR is population based and, hence, less biased with a deeply phenotyped cohort, allowing analyses to control for potential confounding factors and identify clinical and socioeconomic factors that could be used for better risk factor control and effective treatment.¹³

The question of a possible race/ethnic difference in stroke mortality is an extremely important one. SLSR now includes >4000 patients with a long follow-up period up to 16 years. Studies of this size and follow-up time are rare these days. The universal healthcare system (National Health Service) in the United Kingdom makes it an ideal place for population-based epidemiological research.¹⁶ We were able to look at trends and differences between ethnic groups in a systematic fashion using established census criteria and routinely collected clinical variables. One of our findings that survival has improved in a multiethnic population over time is encouraging but not surprising. In a recent study also based on SLSR data, Addo et al²⁰ showed that stroke unit admission improved gradually from 18.9% in the period of 1995–1997 to 78.4% in

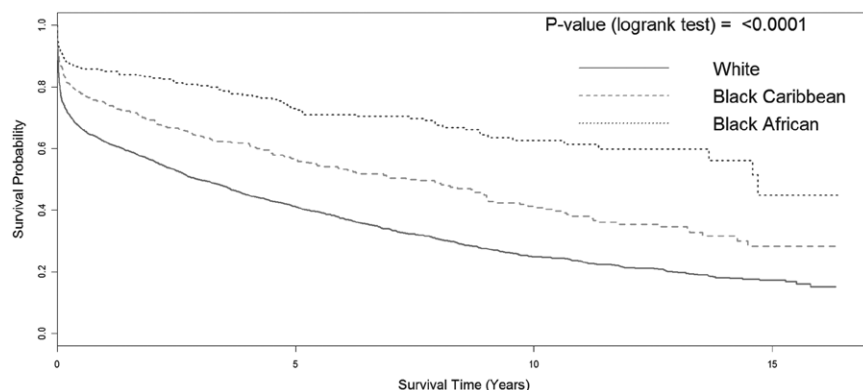


Figure 2. Kaplan-Meier (KM) survival curves by ethnicity.

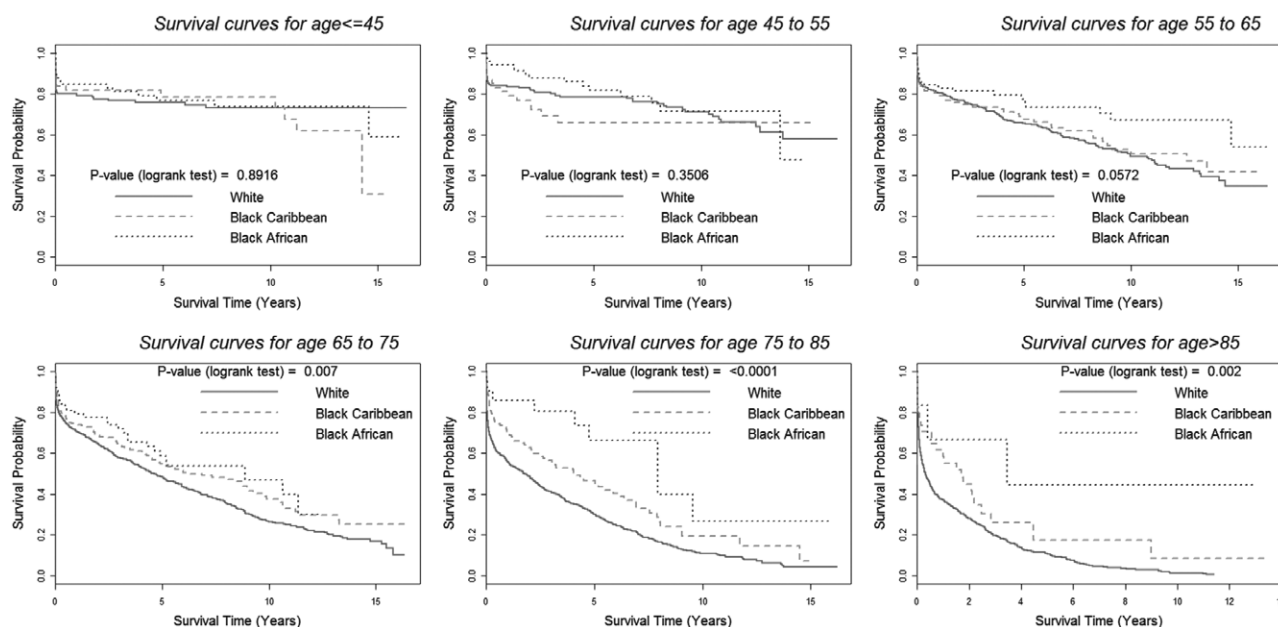


Figure 3. Kaplan-Meier (KM) survival curves by ethnicity and a 10-year age band.

the period of 2007–2009. Consequently, the increase in stroke unit admission in recent years may lead to better survival for recent stroke patients. We also found a differential improvement in survival among ethnic groups, but this could be partly attributed to different sample sizes among white, BC, and BA patients ($n=3005$, 536 and 296, respectively).

Differences in survival between black and white patients after stroke have been addressed in previous studies but with conflicting results. The main reports on survival in black groups are in the United States, where studies of black Americans and Hispanics have been detailed but with more superficial adjustment for confounding factors.²¹ Two population-based stroke registers in US cities, the NOMASS^{17,18} and The GCNKSS,¹¹ found twice the incidence of stroke adjusted for age and sex in black people than in white people, but did not find a significant difference in survival. With regard to in-hospital mortality and case fatality rates, there does not appear to be differences between different ethnic groups.⁴ Population-based studies have also shown comparable results, with a similar 30-day case fatality in minorities and in whites.^{5,12} Despite the commonly held belief that black patients have higher stroke mortality, several recent studies have reported better survival in

black patients with stroke, even after adjustment for various confounding factors.^{13–15} In 1 report, in-hospital mortality was lower among black patients than whites (odds ratio, 0.90; 95% confidence interval, 0.85–0.95).¹⁵ Wolfe et al¹³ showed that black patients in a south London population with first-ever stroke were more likely to survive than white patients. Xian et al¹⁴ also reported that among patients with acute ischemic stroke, black patients had lower mortality than white patients and concluded that this could be the result of differences in receipt of life-sustaining interventions and end-of-life care.

Our finding that the independent survival advantage of black (BC/BA) over white exists in patients over 65 years old after adjustment for confounders is consistent with the previous SLSR result.¹³ However, the current study has advantages of larger sample size ($n=4212$), longer follow-up (16 years), and using self-defined ethnic groups BC and BA instead of 1 black group in the previous study.^{4,22} Potential reasons for explaining survival advantage of black over white include differences in case mix and stroke subtypes,¹⁵ survivorship and selection bias,²³ different methods of risk adjustment,²⁴ different lengths of outcome assessment,²⁵ and differential receipt of effective interventions.¹⁴ Also, a healthy migrant population

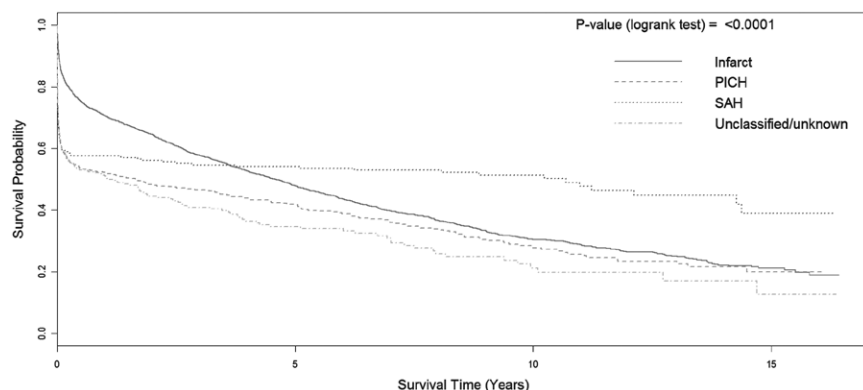


Figure 4. Kaplan-Meier (KM) survival curves by stroke subtype.

Table 2. Factors Influencing All-cause Mortality Among Patients With First-ever Stroke (Patients, 4212; Events, 2605)

	Hazard Ratio	PValue
Age (5 y)	1.24 (1.22–1.27)	<0.0001
Year of stroke (vs 1995–1998)		
1999–2002	0.78 (0.70–0.88)	<0.0001
2003–2006	0.79 (0.70–0.90)	0.0004
2007–2010	0.56 (0.47–0.65)	<0.0001
Female (vs male)	0.98 (0.90–1.07)	0.6709
Ethnic group (vs white)		
Black Caribbean	0.85 (0.74–0.98)	0.0221
Black African	0.61 (0.49–0.77)	<0.0001
Others/unknown	0.81 (0.68–0.95)	0.0107
Socioeconomic status (vs nonmanual)		
Manual	1.09 (0.99–1.21)	0.0917
Others/unknown	1.65 (1.45–1.87)	<0.0001
Case mix		
Glasgow Coma Scale (GCS) <13	2.21 (2.00–2.45)	<0.0001
Unknown GCS	0.71 (0.53–0.94)	0.0189
Incontinent of urine	1.59 (1.42–1.78)	<0.0001
Unknown urine status	2.13 (1.76–2.58)	<0.0001
Pre-Barthel <15	1.17 (1.01–1.35)	0.0390
Unknown pre-Barthel	0.85 (0.68–1.07)	0.1655
Post-Barthel (7 d) <15	1.29 (1.14–1.45)	<0.0001
Unknown post-Barthel	2.70 (2.36–3.08)	<0.0001
Stroke subtype (vs infarct)		
PICH	1.21 (1.07–1.37)	0.0031
SAH	1.45 (1.16–1.81)	0.0011
Unclassified/unknown	1.65 (1.41–1.94)	<0.0001
Effective intervention (vs not admitted to stroke unit but in hospital)		
Stroke unit admission	0.75 (0.68–0.83)	<0.0001
Nonadmitted	0.80 (0.69–0.93)	0.0037
Unknown	0.50 (0.33–0.75)	0.0010
Risk factors before stroke		
Hypertension	0.99 (0.91–1.08)	0.8134
Myocardial infection	1.35 (1.19–1.52)	<0.0001
Atrial fibrillation	1.44 (1.30–1.60)	<0.0001
Previous TIA	1.05 (0.93–1.18)	0.4102
Diabetes mellitus	1.20 (1.07–1.33)	0.0012
Current smoker	1.14 (1.03–1.26)	0.0103
Smoking status unknown	1.64 (1.41–1.91)	<0.0001

Infarct indicates cerebral infarction; PICH, primary intracerebral hemorrhage; SAH, subarachnoid hemorrhage; and TIA, transient ischemic attack.

from Africa and the Caribbean may confer some survival advantage as suggested by Wolfe et al.¹³

As to whether the lower age of stroke onset observed in the black group could explain its survival advantage, our results show that the black group does have a survival advantage that is NOT explained by age, case mix, or other factors, after

adjusting for all the confounding factors in the multivariate Cox model. Age-stratified analyses by a 10-year age band (Figure 3) also show blacks have better survival than whites for those over 65 years old. These comparisons have essentially been carried out after age matching. However, it is still possible that these findings may be influenced by other confounding factors not adjusted for in the models, especially age-related factors, such as comorbidities, which could substantially influence the survival but are not included in the present models.

Apart from the lower age of stroke onset, the black group also had better/increased access to stroke unit care compared with the white group. In a recent *British Medical Journal* article, also from the SLSR (using data between 1995 and 2009), Addo et al²⁰ investigated the factors associated with stroke unit admission and found that the black group was more likely to be admitted to a stroke unit, and the higher odds of admission to a stroke unit in the black group remained significant even after controlling for differences in age, stroke subtype, and severity, and no significant association was found between age and stroke unit admission ($P=0.16$). Possible explanations for the inequalities in access to stroke unit care include the impression that such care is only appropriate for certain subgroups of patients despite the evidence suggesting its beneficial effects on all patients with stroke. It is also possible that these findings are the result of other confounding factors not adjusted for in the models, such as cognitive impairment, as suggested by Addo et al.²⁰ However, the independent survival advantage of the black group over the white group still exists even after controlling for the difference in access to stroke unit care.

As BCs and BAs in the SLSR are mostly first or second generation immigrants, the healthy immigrant effect may exist. Individuals willing and able to immigrate are usually healthy and competitive (ie, self-selection effect).²⁶ Sapoznik et al²⁷ reported new immigrants in Ontario, Canada, had a 30% lower relative risk of premature acute stroke than matched long-term residents. In our study, an independent survival advantage of BC over white patients was found in patients over 65 years old, who were most likely to be first generation migrants, the result of a mass migration of workers from the Caribbeans during 1950s and 1960s.^{28–30} However, this survival advantage of BC over white was not seen in younger stroke patients with different lifestyle and risk exposure. Migration of BA to the United Kingdom is more recent and has been accelerating in the last 20 years.³¹ They are predominantly younger adults and mostly the first generation migrants from Africa. BA patients seem to follow a different/better survival pattern as compared with BC patients. Because of a relatively small number of BA patients ($n=296$) in the study, a larger BA cohort is needed to confirm this survival advantage over white and maybe BC.

Genetics, nutrition, and environment play big roles in the healthy migrant effect of first generation. Although there may be an important genetic influence, not yet identified in the literature, that appears to follow ethnicity in the occurrence and outcome of disease, the ethnicity effects will include not only genetics but also nutrition and environment effects. A healthy migrant population from the Caribbean and Africa may confer some survival advantage, but this advantage is not seen or lost in younger/second generation black patients who were born and live in the United Kingdom and have adapted western

lifestyles. Thus, the ethnicity effects would not necessarily be seen across all age groups and indeed there will be age, period, and cohort effects which will determine different risk exposures (eg, nutrition and environment) for different subgroups.

There are limitations in our study. We do not have cholesterol/pathology data in our stroke register but we do have use of statins. One confounding factor may be the differences in case mix between groups. Although we adjusted for Glasgow Coma Score, acute urinary incontinence and, pre- and post- (7 days) Barthel index, there still could be some residual confounding, which might be further reduced by using more detailed measures of case mix and the pathogenetic subtype of stroke. Case ascertainment is also an issue. Under ascertainment of either the more severe strokes in black people or the more mild strokes in white people seems to be unlikely because the observed ethnicity effect since case ascertainment has been shown to be adequate across SLSR, similar for blacks and whites, and not linked to stroke severity.³² Data on before stroke risk factors, such as the history of myocardial infarction, atrial fibrillation, transient ischemic attack, and tobacco consumption, were collected at initial assessment on all patients regardless of ethnicity through general practice or hospital records and face-to-face interviews by trained study nurses and field workers. However, the possibility of differential case ascertainment in different ethnic groups may not be completely ignored and may influence the interpretation of the survival data.

Conclusion

A number of factors appear to be associated with survival advantage but importantly survival has improved in a multiethnic population over time and it is more evident in white than in black (BC/BA) patients. The increase in stroke unit admission in recent years may contribute to this improvement in survival. The independent survival advantage of black (BC/BA) over white in those aged over 65 may be a healthy migrant effect of first generation migrants. However, this survival advantage of black (BC/BA) over white is not seen in younger stroke patients with different lifestyle and risk exposure.

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Disclosures

None.

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SUPPLEMENTAL MATERIAL

Supplemental Table 1

Supplemental Table 2

Supplemental Table 3

Supplementary table 1: Factors influencing all-cause mortality among patients with first-ever stroke (including interaction terms) (Patients: 4212; Events: 2605)		
	Hazard Ratio	P-value
Age (5 yrs)	1.26(1.23,1.29)	<0.0001
Year of stroke (vs. 1995-1998): 1999-2002	0.78(0.70,0.88)	<0.0001
2003-2006	0.79(0.70,0.90)	0.0003
2007-2010	0.55(0.47,0.65)	<0.0001
Female (vs. Male)	0.97(0.89,1.06)	0.4806
Ethnic group (vs. White): Black Caribbean	1.78(0.81,3.90)	0.1512
Black African	1.58(0.59,4.23)	0.3645
Others/unknown	1.01(0.42,2.43)	0.9766
Socioeconomic status (vs. Non-manual): Manual	1.09(0.99,1.21)	0.0823
Others/unknown	1.65(1.46,1.87)	<0.0001
Case mix: Glasgow Coma Scale (GCS) < 13	2.21(1.99,2.45)	<0.0001
Unknown GCS	0.71(0.53,0.95)	0.0219
Incontinent of urine	1.58(1.42,1.77)	<0.0001
Unknown urine status	2.12(1.75,2.57)	<0.0001
Prior Barthel < 15	1.16(1.00,1.34)	0.0453
Unknown prior Barthel	0.86(0.68,1.07)	0.1728
Post Barthel (7 days) < 15	1.28(1.14,1.45)	0.0001
Unknown post Barthel	2.70(2.36,3.08)	<0.0001
Stroke subtype (vs. Infarct): PICH	1.20(1.05,1.36)	0.0054
SAH	1.44(1.15,1.80)	0.0013
Unclassified/unknown	1.64(1.40,1.93)	<0.0001
Effective intervention: (vs. not admitted to stroke unit but in hospital) Stroke unit admission	0.75(0.68,0.83)	<0.0001
Non-admitted	0.79(0.68,0.92)	0.0028
Unknown	0.50(0.33,0.76)	0.0012
Risk factors prior to stroke: Hypertension	0.99(0.91,1.08)	0.8447
Myocardial infarction	1.35(1.20,1.53)	<0.0001
Atrial fibrillation	1.43(1.29,1.58)	<0.0001
Previous TIA	1.06(0.94,1.19)	0.3649
Diabetes	1.21(1.08,1.35)	0.0006
Current smoker	1.16(1.04,1.28)	0.0055
Smoking status unknown	1.63(1.40,1.90)	<0.0001
Interaction: Black Caribbean by Age (5 yrs)	0.95(0.90,1.00)	0.0641
Black African by Age (5 yrs)	0.93(0.86,1.00)	0.0624
Others/unknown by Age (5 yrs)	0.98(0.93,1.05)	0.6216

Note: Infarct=Cerebral Infarction; PICH=Primary Intracerebral haemorrhage; SAH=Subarachnoid Haemorrhage; TIA=Transient Ischemic Attack.

Supplementary table 2: Factors influencing all-cause mortality among patients with first-ever stroke (age group > 65 yrs old)

	Hazard Ratio	P-value
Age	1.04(1.04,1.05)	<0.0001
Year of stroke (vs. 1995-1998):		
1999-2002	0.82(0.72,0.93)	0.0017
2003-2006	0.83(0.72,0.95)	0.0068
2007-2010	0.55(0.45,0.66)	<0.0001
Female (vs. Male)	0.96(0.87,1.05)	0.3554
Ethnic group (vs. White):		
Black Caribbean	0.77(0.65,0.90)	0.0014
Black African	0.55(0.40,0.76)	0.0003
Others/unknown	0.75(0.61,0.91)	0.0040
Socioeconomic status (vs. Non-manual):		
Manual	1.08(0.97,1.21)	0.1616
Others/unknown	1.71(1.48,1.96)	<0.0001
Case mix:		
Glasgow Coma Scale (GCS) < 13	2.24(2.00,2.50)	<0.0001
Unknown GCS	0.67(0.48,0.94)	0.0215
Incontinent of urine	1.57(1.39,1.77)	<0.0001
Unknown urine status	2.17(1.75,2.70)	<0.0001
Prior Barthel < 15	1.19(1.02,1.38)	0.0248
Unknown prior Barthel	0.92(0.72,1.18)	0.5136
Post Barthel (7 days) < 15	1.28(1.12,1.46)	0.0003
Unknown post Barthel	2.45(2.11,2.84)	<0.0001
Stroke subtype (vs. Infarct):		
PICH	1.21(1.05,1.40)	0.0088
SAH	1.35(0.97,1.88)	0.0724
Unclassified/unknown	1.76(1.49,2.09)	<0.0001
Effective intervention: (vs. Not admitted to stroke unit but in hospital)		
Stroke unit admission	0.77(0.68,0.86)	<0.0001
Non-admitted	0.76(0.64,0.89)	0.0010
Unknown	0.54(0.34,0.85)	0.0078
Risk factors prior to stroke:		
Hypertension	0.98(0.88,1.08)	0.6422
Myocardial infarction	1.40(1.22,1.59)	<0.0001
Atrial fibrillation	1.42(1.28,1.59)	<0.0001
Previous TIA	1.04(0.92,1.18)	0.5259
Diabetes	1.19(1.05,1.34)	0.0059
Current smoker	1.19(1.06,1.33)	0.0029
Smoking status unknown	1.46(1.23,1.74)	<0.0001

Supplementary table 3: Factors influencing all-cause mortality among patients with first-ever stroke (age group ≤ 65 yrs old)

	Hazard Ratio	P-value
Age	1.02(1.01,1.04)	0.0001
Year of stroke (vs. 1995-1998):		
1999-2002	0.69(0.53,0.91)	0.0075
2003-2006	0.58(0.42,0.80)	0.0010
2007-2010	0.58(0.39,0.86)	0.0066
Female (vs. Male)	0.99(0.79,1.23)	0.9138
Ethnic group (vs. White):		
Black Caribbean	1.10(0.82,1.48)	0.5070
Black African	0.73(0.51,1.03)	0.0754
Others/unknown	0.97(0.70,1.33)	0.8417
Socioeconomic status (vs. Non-manual):		
Manual	1.16(0.91,1.50)	0.2349
Others/unknown	1.58(1.17,2.14)	0.0031
Case mix:		
Glasgow Coma Scale (GCS) < 13	2.47(1.85,3.30)	<0.0001
Unknown GCS	0.93(0.49,1.75)	0.8200
Incontinent of urine	1.77(1.31,2.40)	0.0002
Unknown urine status	2.02(1.31,3.12)	0.0014
Prior Barthel < 15	1.79(0.89,3.59)	0.1010
Unknown prior Barthel	0.79(0.43,1.43)	0.4305
Post Barthel (7 days) < 15	1.11(0.83,1.49)	0.4814
Unknown post Barthel	3.58(2.67,4.79)	<0.0001
Stroke subtype (vs. Infarct):		
PICH	1.01(0.76,1.34)	0.9487
SAH	1.46(1.04,2.06)	0.0282
Unclassified/unknown	1.40(0.85,2.28)	0.1823
Effective intervention:		
(vs. Not admitted to stroke unit but in hospital)		
Stroke unit admission	0.69(0.53,0.88)	0.0031
Non-admitted	0.86(0.59,1.26)	0.4409
Unknown	0.38(0.13,1.14)	0.0849
Risk factors prior to stroke:		
Hypertension	1.16(0.93,1.45)	0.1777
Myocardial infarction	1.20(0.85,1.69)	0.2932
Atrial fibrillation	1.67(1.17,2.38)	0.0045
Previous TIA	1.03(0.76,1.40)	0.8423
Diabetes	1.27(0.97,1.66)	0.0777
Current smoker	1.30(1.03,1.65)	0.0280
Smoking status unknown	2.81(1.96,4.01)	<0.0001